P-REACT
Project Overview

Project Coordination: Juan Arraiza

E-mail: pc@p-react.eu

Technical Coordination: Mark Sugrue

Email: tc@p-react.eu

TABLE OF CONTENTS

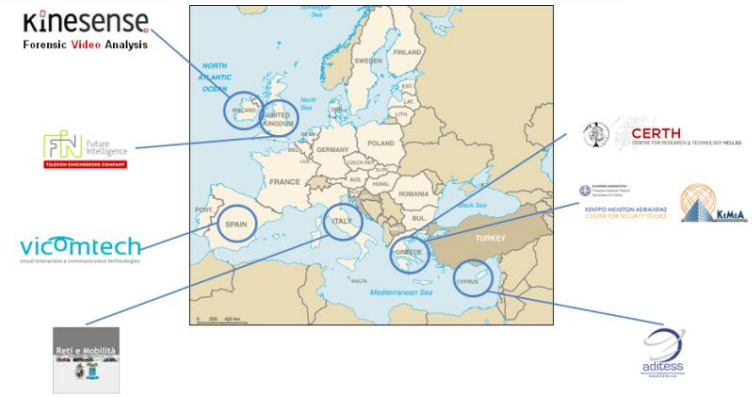
- Key message
- Introduction to the P-REACT project
- Introduction to the P-REACT solution
- Goals, status as of July'15, and future work of all the key components
- Social, Ethical, Legal, and Privacy aspects
- Trials

Key Message

- P-REACT is…
  - a low-cost surveillance system…
  - that combines video, depth, and audio analysis technologies…
  - distributed between a local embedded platform (on-site) and a central service (cloud)…
  - focused in the prevention and early detection of petty crimes (also known as volume crimes)…
  - societal, ethical, legal, and privacy friendly.

The P-REACT project

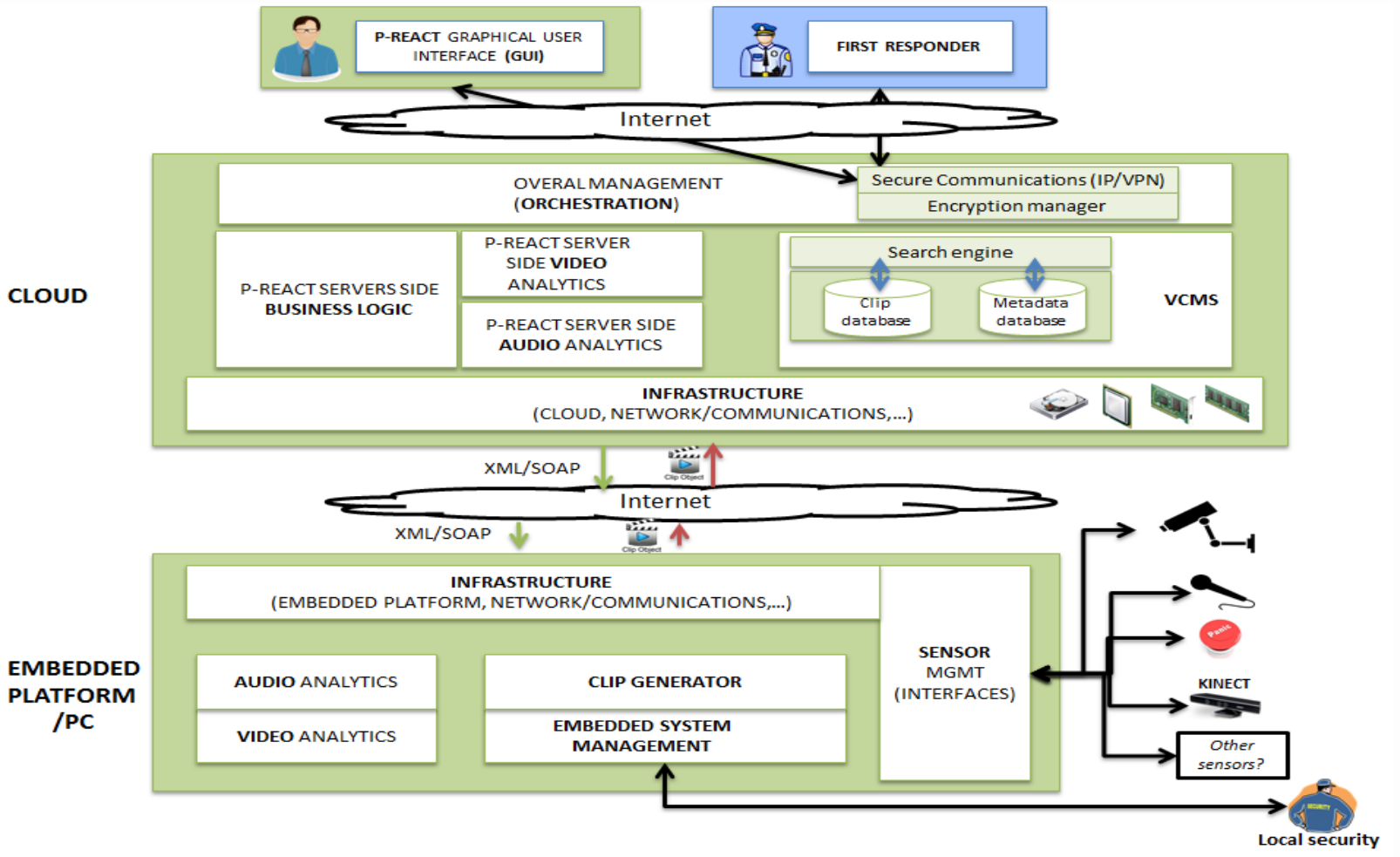
- Some basic figures and key aspects:
  - 7 partners from 6 countries
  - 2 years project (April'14 – March'16)
  - 1.9 M Euros total budget (*1.5 M Euros EU funding*)
  - 11 members in the End-user advisory board



The P-REACT project

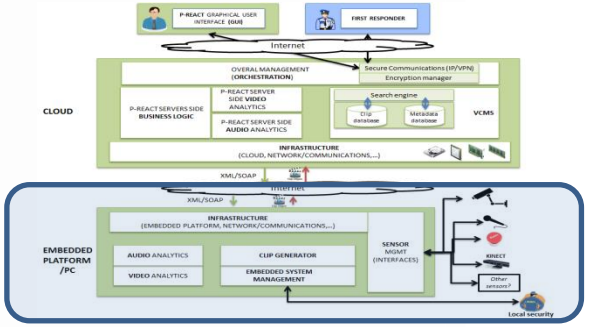
- **Objective 1**: To design and develop a cost-effective solution for petty crimes detection, response, investigation and analysis.
- **Objective 2**: To foster collaboration and communication between key users.
- **Objective 3**: Deliver novel video and audio analytics to detect petty crime incidents and develop crime reporting and analysis solutions to strengthen decision-making and responses.
- **Objective 4**: Delivery of novel low cost embedded framework with local intelligence and real-time alert categorization.
- **Objective 5**: To design and develop a novel cloud-based Video Content Management System (VCMS) that is capable of being delivered as service.
- **Objective 6**: To exploit the use of semantic-technologies to aid crime analysis and mapping which will help forecast, prevent and detect future petty crimes.
- **Objective 7**: To analyse technical barriers in the standardisation and scalability of the technologies and to ensure that any societal, ethical and legal issues are properly balanced and addressed.
- **Objective 8**: Demonstration, Validation and Evaluation of the proposed system according to defined user scenarios.

The P-REACT solution



P-REACT

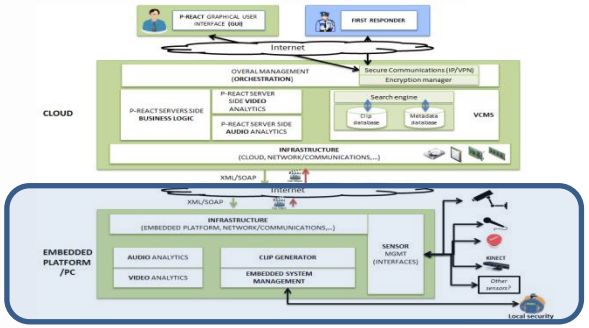
Embedded System



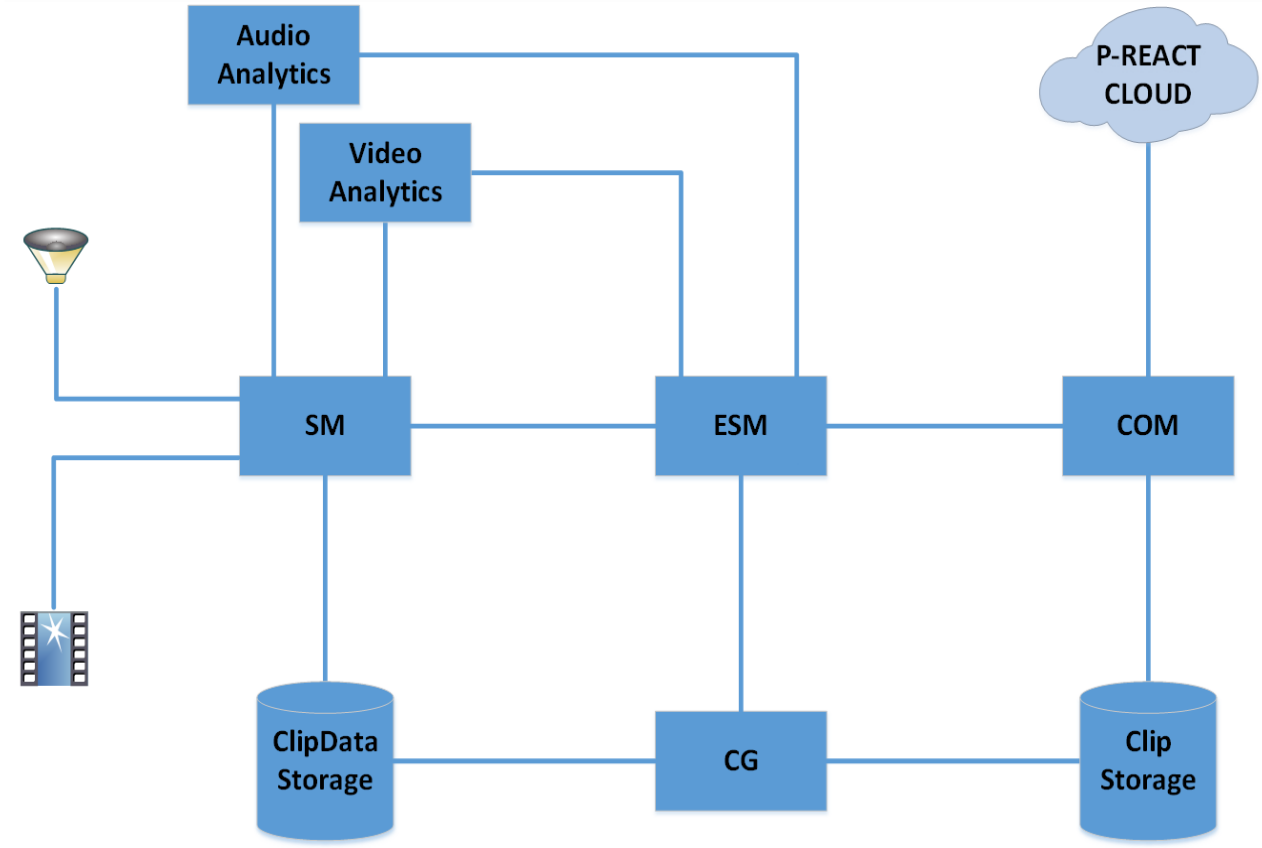
- **Embedded System Manager**
  - Is responsible for effectively coordinating all the components of the embedded system
- **Sensors Manager**
  - Acquires sensors' data or gets/updates sensors' configuration
- **Analytics Module**
  - Perform the appropriate analysis in order to detect petty crimes
  - 3 Sub-Modules for Video, Depth and Audio analysis
- **Clip Generator**
  - Is fired when a petty crime has been detected and gathers the necessary data

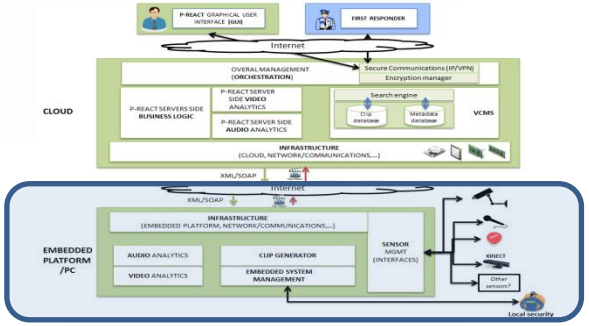
Embedded System

- Embedded Systems, with Ubuntu Linux, are installed in P-REACT's users premises towards providing a first level detection of petty crime incidents.
- Currently are available:
  - Single and dual core embedded systems enabling the realization of a low cost solution.
  - Eight core (with GPU) embedded systems enabling for the deployment of more sophisticated petty crime detection algorithms.



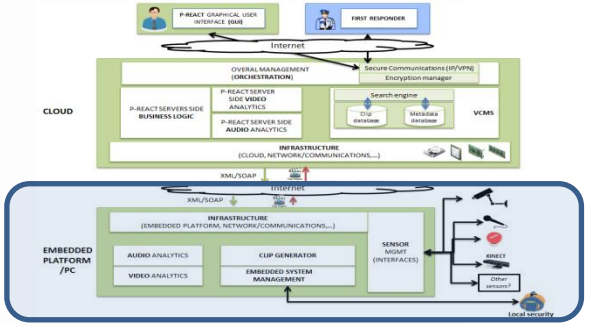
Embedded System Key SW Modules





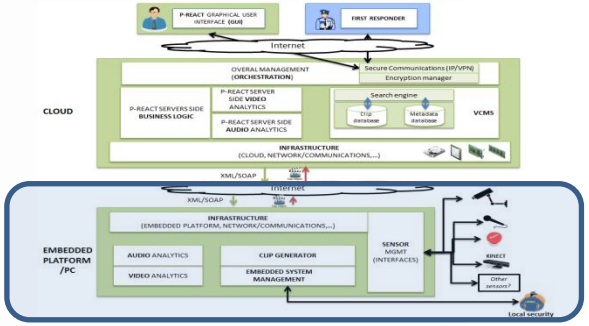
Sensors

- Several USB, Network cameras and microphone sensors have been tested and integrated in the Embedded System's operational pipeline.



P-REACT

Video Analytics (Embedded): Video



- **Types of detected events:**
  - Fighting
  - Chasing
- **Results (accuracy) on the BEHAVE dataset:**

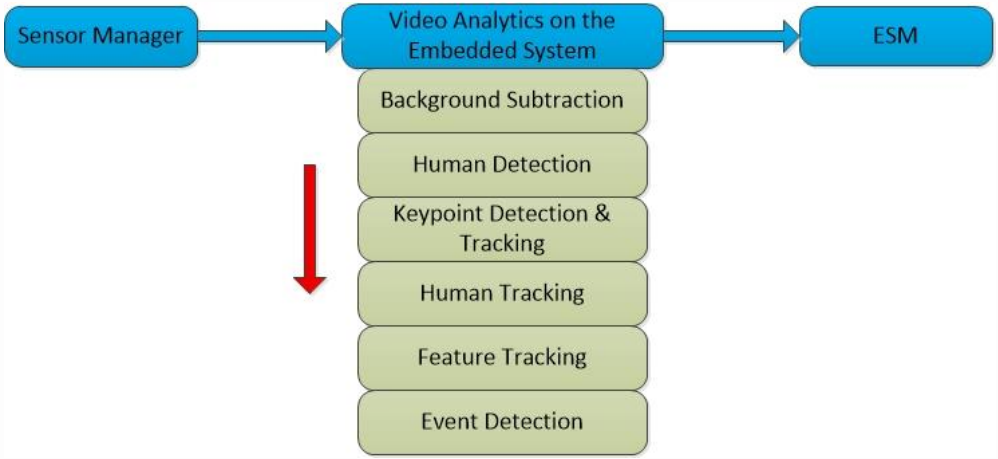
RT	Baseline	Baseline+MHs
Fighting	82.57	88.70
Chasing	71.54	77.24

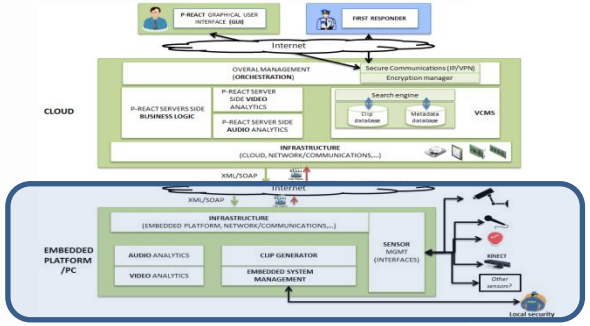
- **Status:**
  - Development finished
  - Testing and optimizations remaining

P-REACT

Video Analytics (Embedded): Video

- **Problem:**
  - Detect abnormal events in real time from RGB data



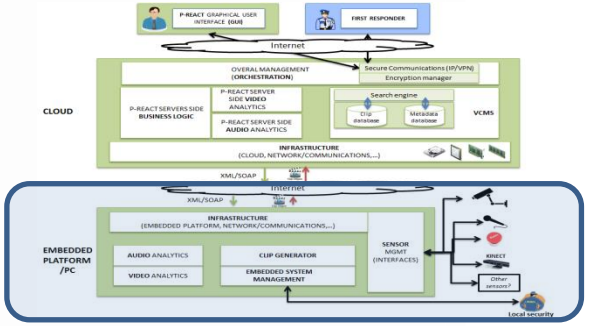


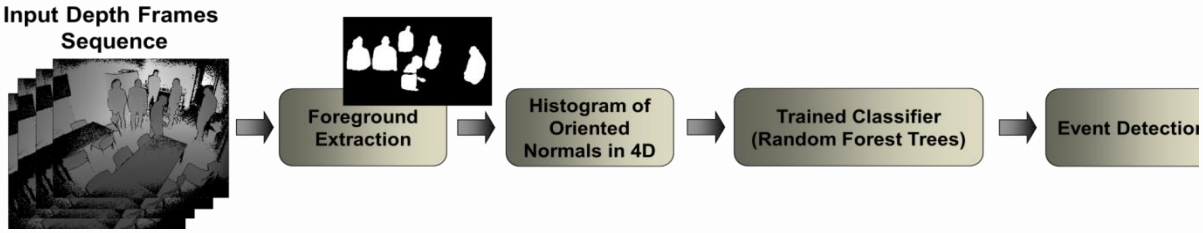
- **Methodology:**
  - Subtract background to reduce computational costs
  - Detect and track humans using keypoints
  - Detect abnormal events using humans' position and motion

P-REACT

Video Analytics (Embedded): Depth

- **Problem:**
  - To be able to detect abnormal events (petty crimes) using only the depth stream from a Microsoft Kinect V2 sensor in (close to) real time





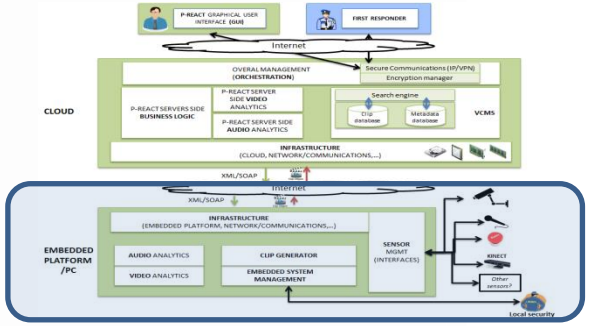
- **Methodology:**
  - Input: depth images sequence
  - Foreground extraction
  - Feature Extraction (HON4D) [1]
  - Random Forests Classifier → Event Detection

[1] Omar Oreifej and Zicheng Liu. HON4D: Histogram of Oriented 4D Normals for Activity Recognition from Depth Sequences, CVPR 2013.

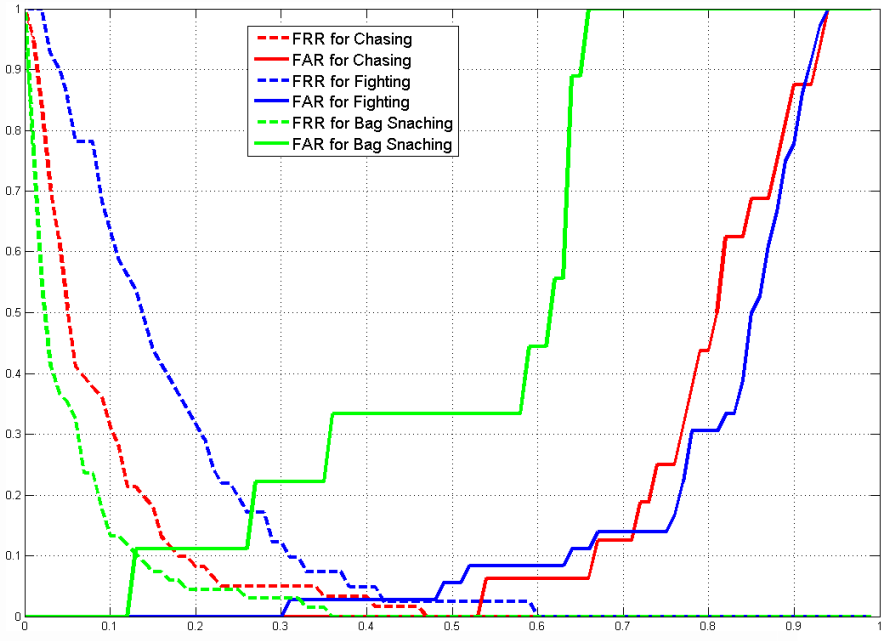
P-REACT

Video Analytics (Embedded): Depth

- **Types of detected events:**
  - Fighting
  - Chasing
  - Bag Snatching



- **Results (Equal Error Rates):**
  - Chasing: 0% at 0.5
  - Fighting: 3% at 0.45
  - Bag Snatching: 11% at 0.13

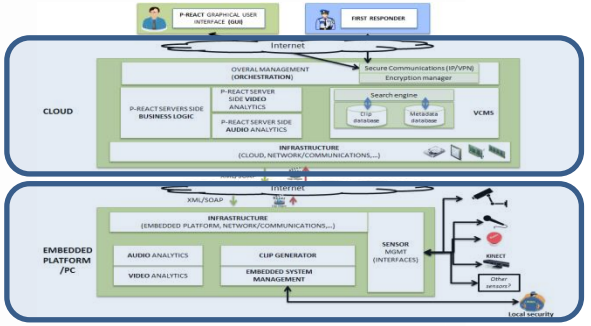


- **Status:**
  - Development finished
  - Testing and optimizations remaining

P-REACT

Audio Analytics in more detail

Audio covers a 360-degree area and adds as much to our understanding of events as the captured images



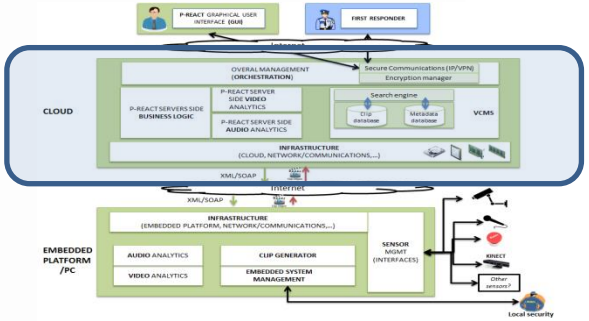
- Based on well-established methods from the fields of audio coding, machine learning and speech recognition
- Allows efficient operation on low cost power limited devices (or embedded systems)
- Manages the detection abnormal events:
  - Screaming
  - Gunshots
  - Glass Breaking
- Critical for the seamless triggering of a surveillance system

Parameter	Configuration		
	#1	#2	#3
F_S (kHz)	8	8	8
Block (ms)	140	100	140
FBank	22	22	22
MFCC	13	13	10
Classification Error	**1.40%**	**1.60%**	**1.60%**
Time (ms)	85.74	89.06	65.13

Figures obtained from statistical testing with the deployment of bootstrapping with replacement and 5x2 cross validation f-testing

P-REACT

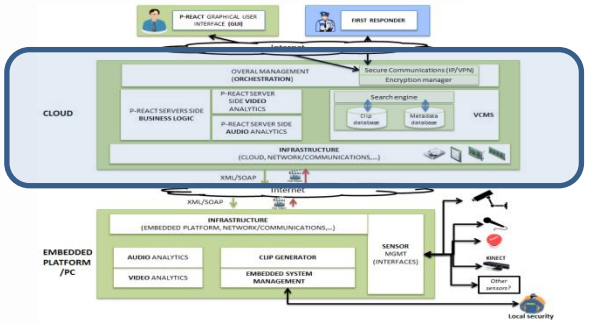
The Cloud side

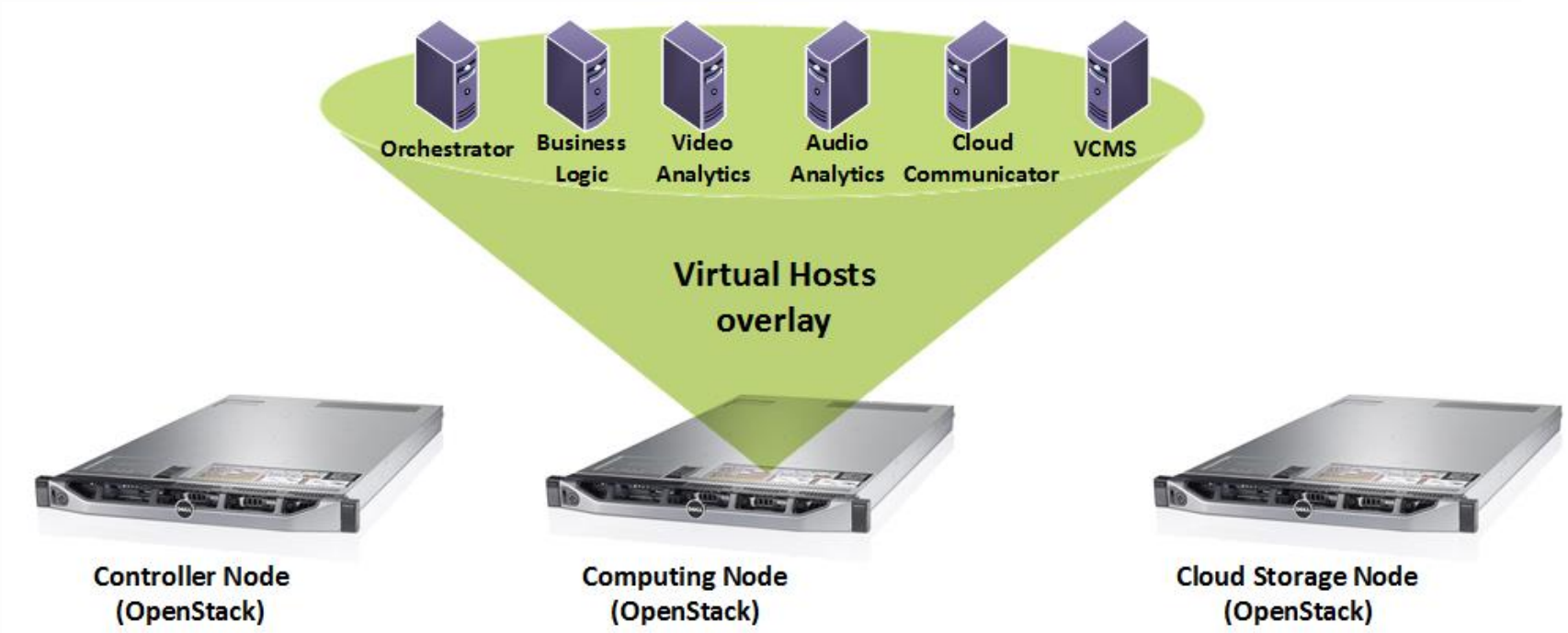


- **Orchestration**
  - Central point via which all communication takes place
  - Logging operations
- **Brain**
  - Manages the clips, VCMS and interfaces with the human operators
  - Is responsible for Alert raising, interaction & control, real time monitoring
- **Analytics**
  - Analytics on the cloud (video, depth and audio) aim to provide richer information about the petty crime and the people involved
- **Video Content Management System (VCMS)**
  - Manages and updates metadata
  - Provides fast indexing and retrieval of content
- **Clip Storage**
  - Stores the actual clip data (video, depth, audio)

Cloud Infrastructure

- Deployment of:
  - Openstack and corresponding controller and computing nodes.
  - Cloud storage, Virtual OSes, firewalls, ACLs and backup solution.

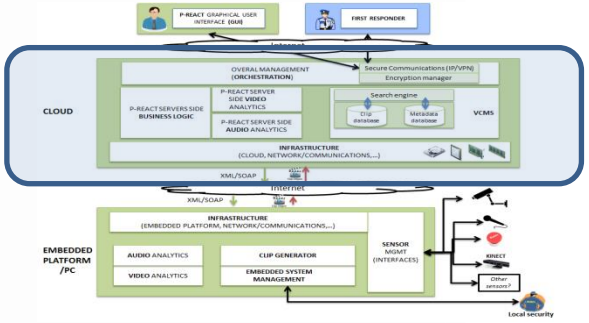




P-REACT

VCMS in more detail

The VCMS is a content management system for the efficient management, archiving, fast-indexing, processing of multimedia content through a modular architecture



- **Authentication & Security Module**
  - Its use is possible only to authenticated users
  - Implements authenticity levels for users
  - Allows the definition of static metatags

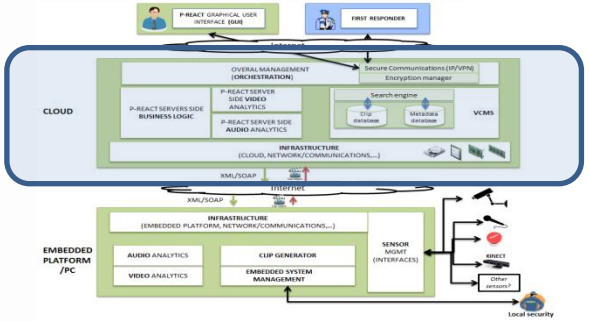
  } Important for complying with ethical issues

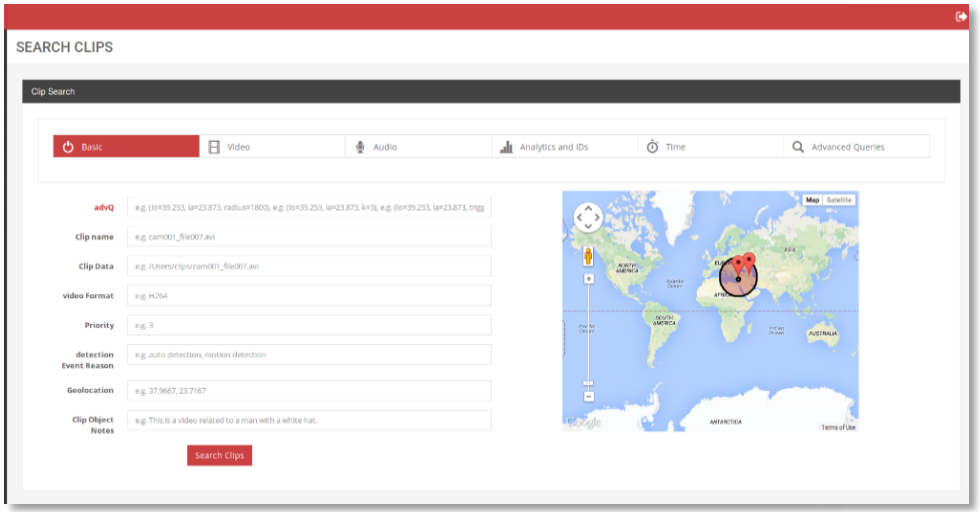
  - Maintains a log of all actions and events taking place
- **Repository Module**
  - Handles data access and configuration issues
    - Sensitive data may be associated with an expiration data
  - Implements functionality **expanding**, **updating**, **searching** the repository
- **Processing Module**
  - Supports several existing containers and formats
  - Additional formats may be added as pluggable modules
  - May be used for transcoding, compressing or manipulating stored content

P-REACT

VCMS in more detail

- **User Privileges**: supports different levels of authentication
  - *Basic*: view content
  - *Intermediate*: view, update, download content, access to users' repository
  - *Tech Admin*: manages all technical aspects, no access to actual content
  - *Administrator*: manages both technical and data aspects





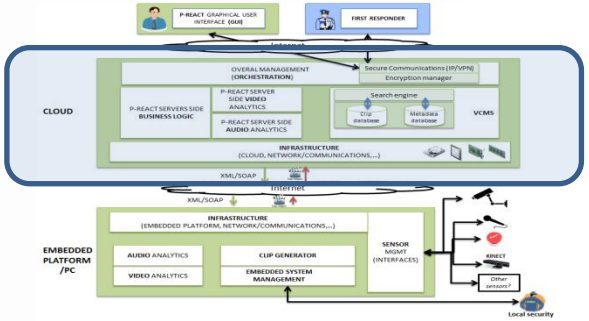
- **Advanced Queries**
  - Proximity searches
  - Integrated maps
  - Calculates duration of incident
  - Provides field-related information

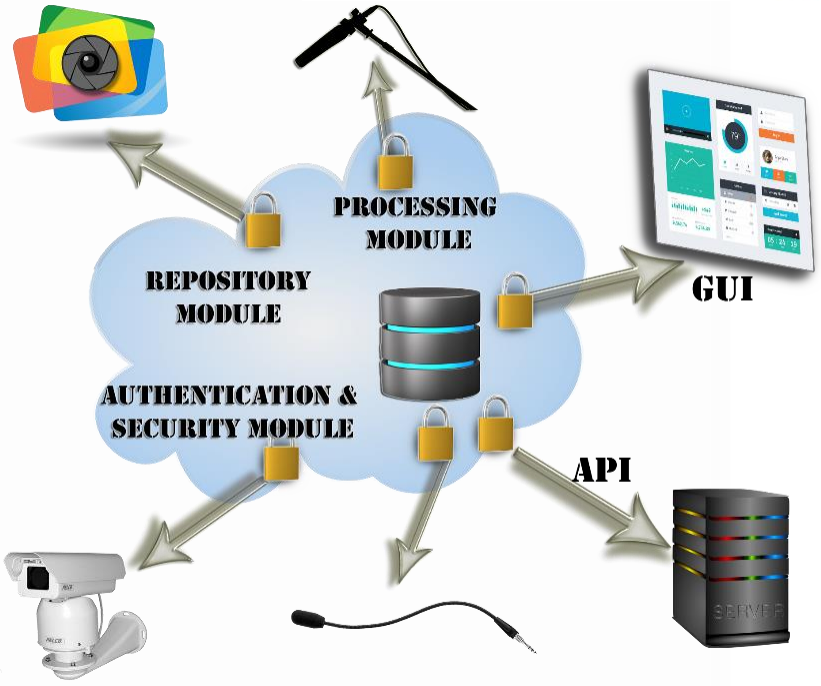
P-REACT

VCMS in more detail: Use Case

1. **Multimedia content is uploaded to the Versatile Media CMD from multiple sources through established protocols (ftp, http, etc.)**
   - Commercial IP cameras
   - Video Servers
   - Surveillance Microphones
   - Photo Cameras
2. **Metadata for each file are generated according to its attributes.**
3. **Authenticated users may access the system through:**
   - The GUI
   - Initiating callbacks to API

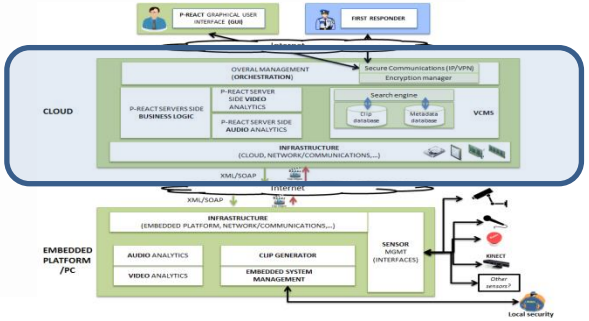
Time tracking metadata are also automatically generated allowing the system to erase content that should not be retained any longer.



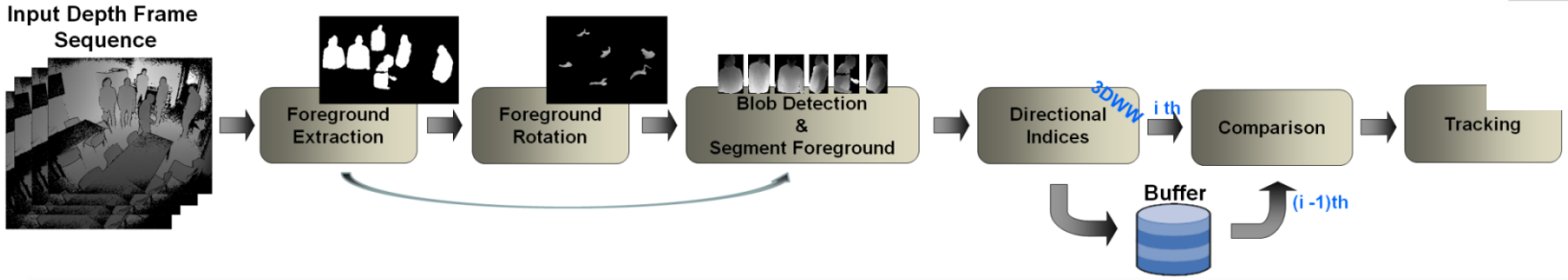


P-REACT

Video Analytics (Cloud): Depth



- **Problem:**
  - Given an input depth stream from an embedded system, to identify the involved people in depth streams stemming from other embedded systems.



- **Methodology:**
  - Foreground extraction & rotation to top-view
  - Blob detection (on top-view) and foreground segmentation (real-view)
  - Feature extraction - 3D Weighted Walkthroughs (3DWW) [1]
  - Feature comparison → identification

[1] Stefano Berretti, Alberto Del Bimbo, Pietro Pala, "3D Face Recognition Using Isogeodesic Stripes", *IEEE Transactions on Pattern Analysis & Machine Intelligence*, vol.32, no. 12, pp. 2162-2177, December 2010

P-REACT

Social, Ethical, Legal & Privacy Issues Management

- Analysis of how collected data will be handled based on the applicable legal and regulatory requirements
  - Identify any induced risks and evaluate protection mechanisms and processes
- Identification and address of privacy and ethical concerns within the early stages of platform's design and development
- Adhere to Privacy by Design Approach
  - Based on underlying legal and normative framework at EU level

P-REACT

Social, Ethical, Legal & Privacy Issues Management

- Performed a Privacy Impact Assessment (PIA)
  - Validated it's results by EAB external members
- Set out
  - Guiding Design and Implementation Principles
  - Implementation and Deployment Guidelines
  - Implementation and Deployment Checklist
    - As interim internal ethical and data privacy audits
- Definition of Procedures for Protection of Privacy for Informed Voluntary Participants
  - Nomination of Data Protection Expert

The trials of the project

- Two trials, one in Bologna, Italy, (transport use case) and one in Athens, Greece, (small shop or gas station use case).
- Trials will be conducted in controlled areas, real to operational environment, with the participation of external experts.
- Best practices and experience from other finished and on-going projects will be used.
- The work package focused on the trials starts in July 2015 and further definition and preparation of the trials will take pace until Autumn 2015.

Thank you for your attention!

More info at:

- *Website: http://p-react.eu/*
- *E-mail: contact@p-react.eu*
- *LinkedIn: www.linkedin.com/groups?gid=8175906*